

Ionization Energy (I.E)  $\propto$  Ionization Potential  
 $\rightarrow$  Energy required by  $e^-$  to make transition from ground state ( $n=1$ ) to  $n=\infty$  for single  $e^-$  species

$$\Delta E_{n_1 \rightarrow n_2} = 13.6 Z^2 \left( \frac{1}{n_1^2} - \frac{1}{n_2^2} \right) \text{ eV}$$

$n_1 \rightarrow$  Initial level ( $n=1$ )  
 $n_2 \rightarrow$  Final level ( $\infty$ )

$$I.E = \Delta E_{1 \rightarrow \infty} = 13.6 Z^2 \left[ \frac{1}{(1)^2} - \frac{1}{(\infty)^2} \right] \text{ eV}$$

$I.E$  or  $I.P$

$$I.E = 13.6 Z^2$$

$$I.E(H^+) = 13.6 \times 1^2 \text{ eV} = 2.18 \times 10^{-18} \times 1 \text{ J/atom}$$

$$I.E(H) = 13.6 \text{ eV}$$

$$I.E(Li^+) = 13.6 \times (3)^2 \text{ eV}$$

$$I.E(Be^{3+}) = 13.6 \times (4)^2 \text{ eV}$$

$$I.E(Be^{3+}) = 2.18 \times 10^{-18} \times 4^2 \text{ J/atom} = \frac{2.18 \times 10^{-18} \times (4)^2}{4.18} \text{ Cal/atom}$$

$$1 \text{ eV/atom} = 96.5 \text{ KJ/mole}$$

$$1 \text{ eV} = 1.6 \times 10^{-19} \text{ J/atom} = 1.6 \times 10^{-19} \times N_A \text{ J/mole} = 96.5 \times 10^3 \text{ J/mole} = 96.5 \text{ KJ/mole}$$

⑧ Seperation Energy (SE) or Binding Energy BE

$\rightarrow$  energy required by  $e^-$  to make transition from any excited state to  $\infty$ .

$$SE = \Delta E_{n \rightarrow \infty} = 13.6 Z^2 \left( \frac{1}{n^2} - \frac{1}{(\infty)^2} \right) \text{ eV}$$

$n \Rightarrow$  any level except  $n=1$

$$SE_n = +13.6 \frac{Z^2}{n^2} \text{ eV/atom}$$

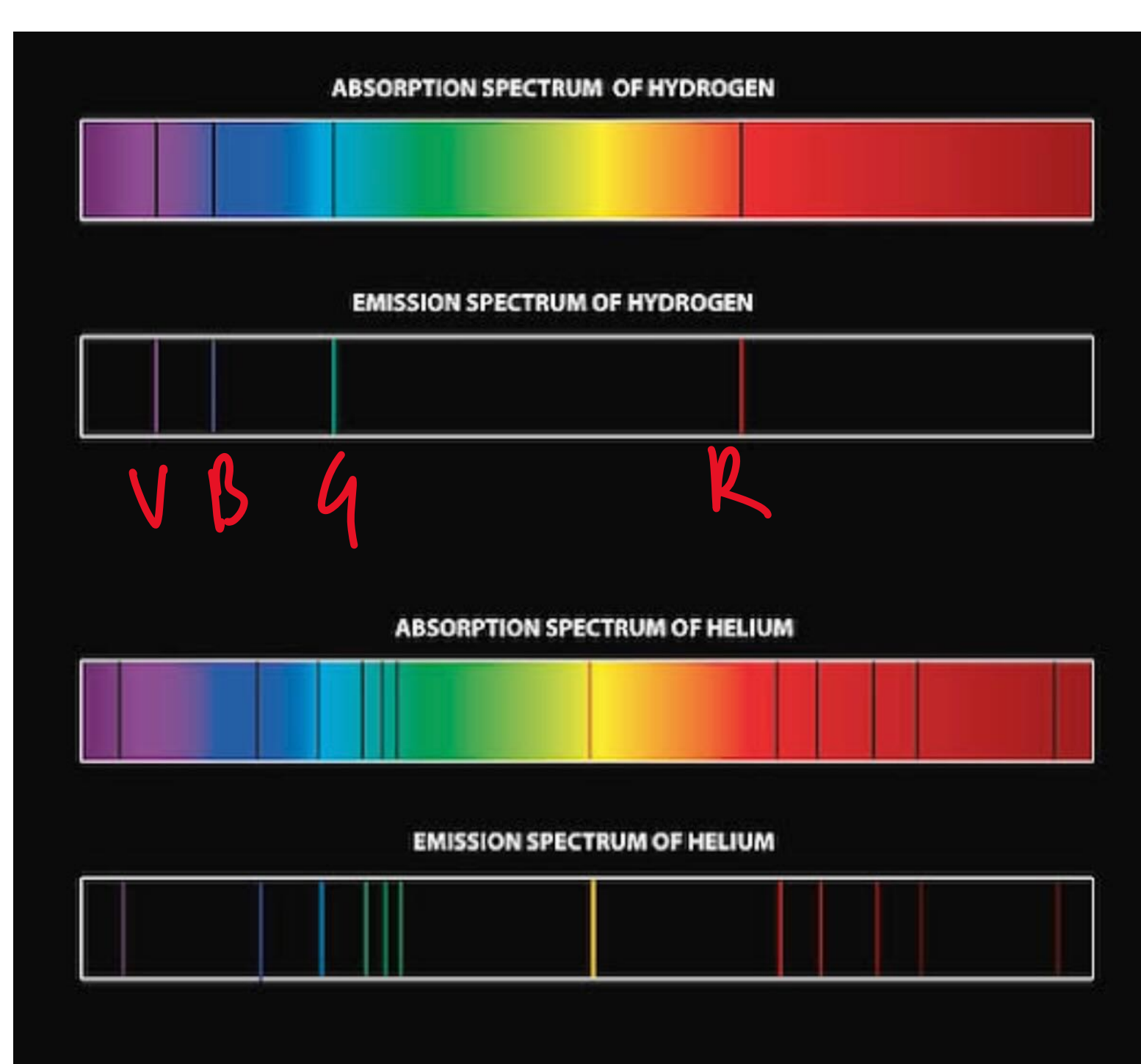
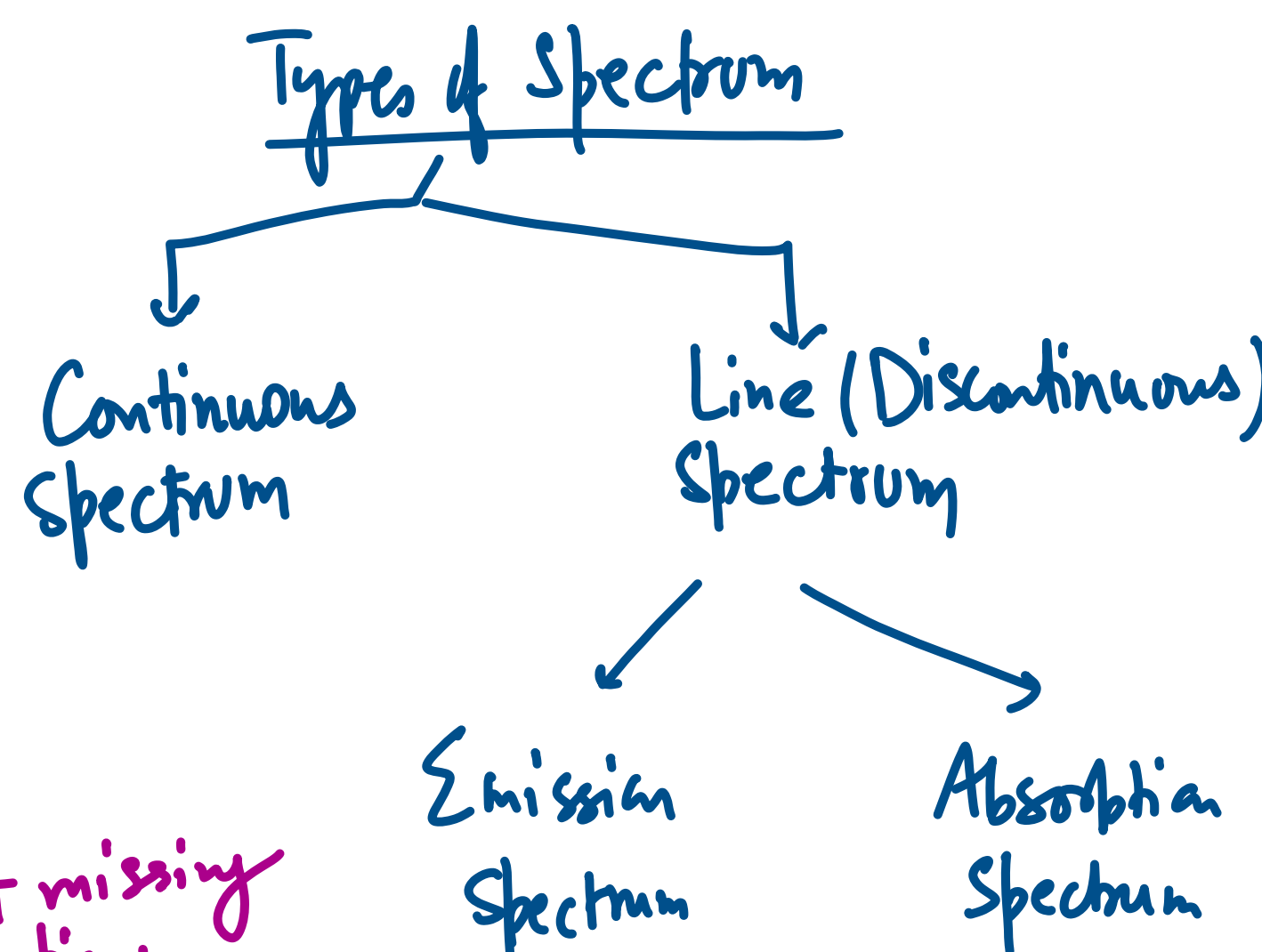
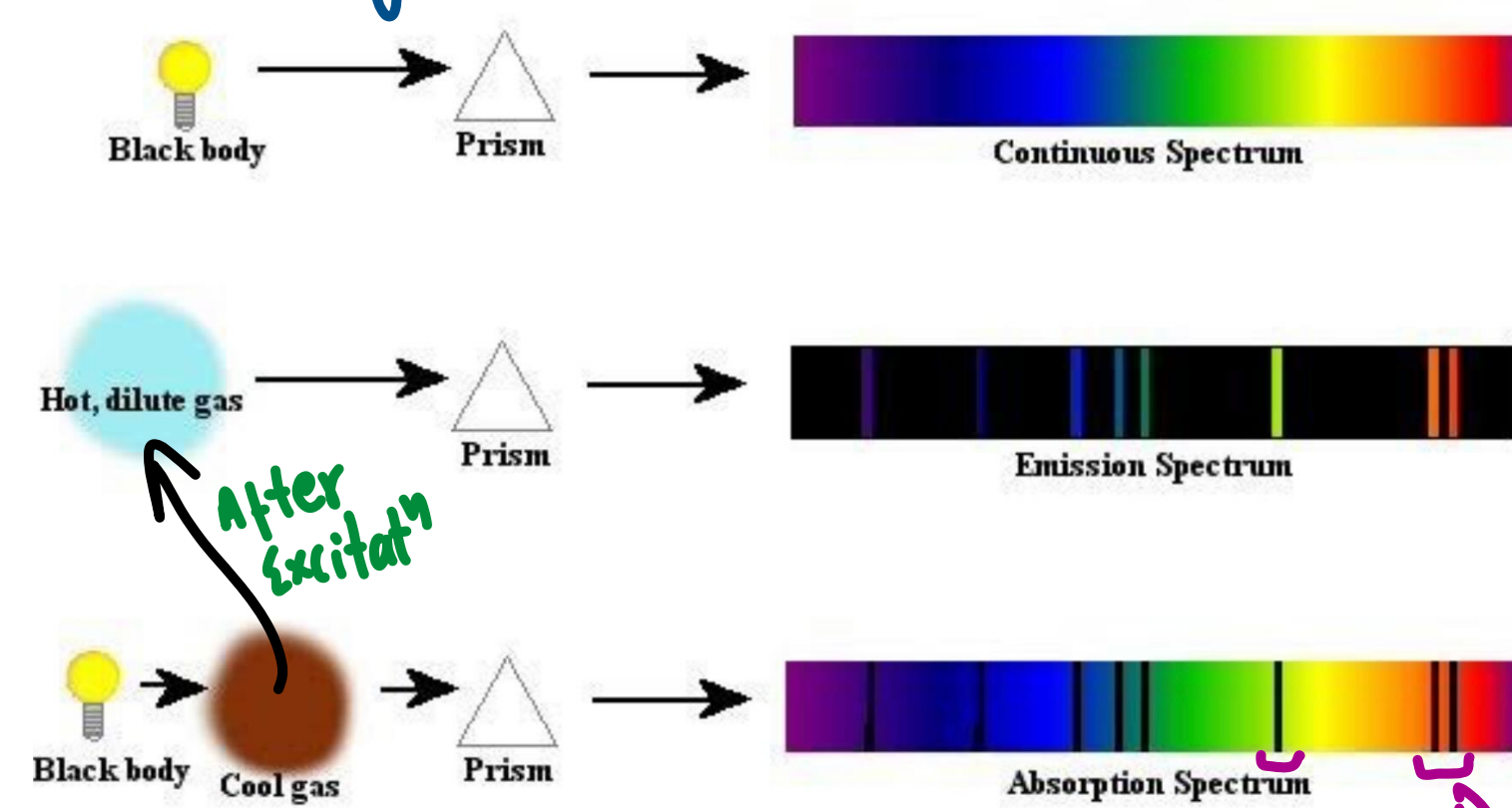
SE & IE  $\Rightarrow$  +ve

Q3 SE of 2<sup>nd</sup> Excited state of  $He^+$ ?

$$SE_n \therefore n=3 \quad SE_3(He^+) = +13.6 \times \frac{4}{(3 \times 3)} \text{ eV}$$

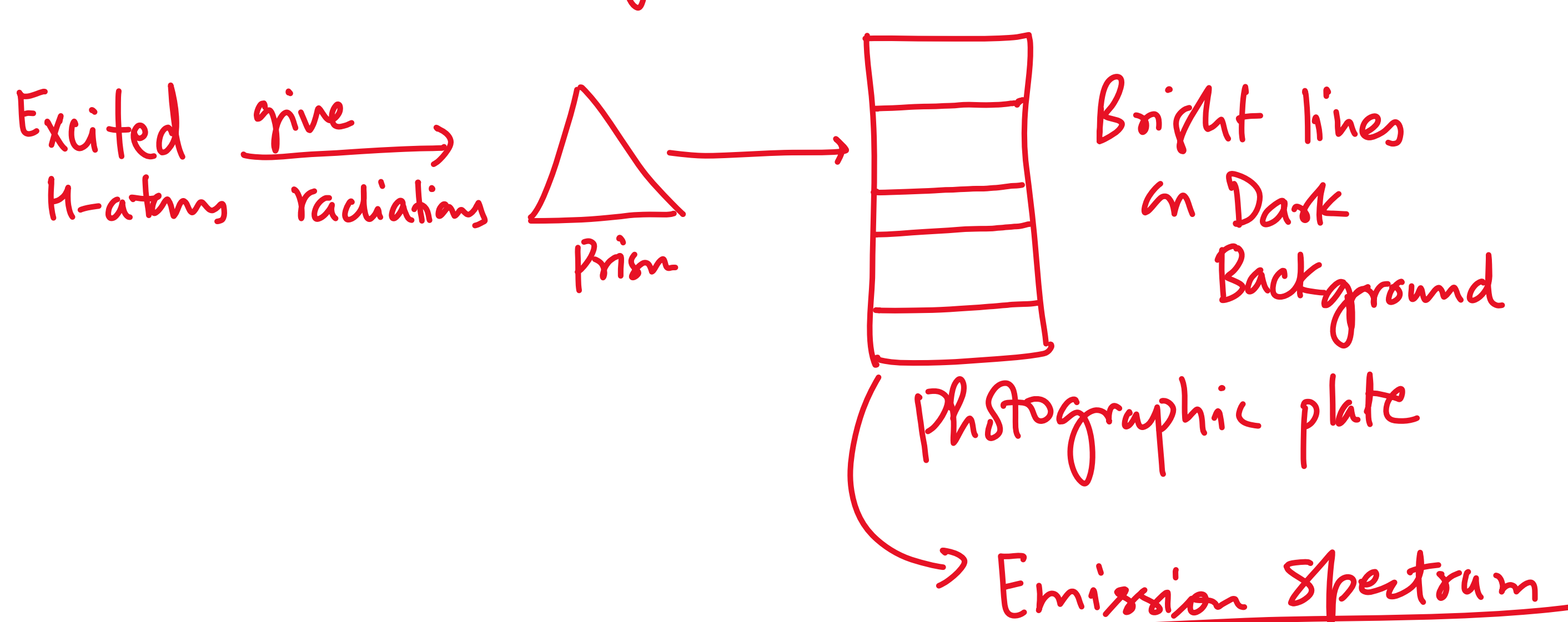
## Spectra

Arrangement of radiations on photographic plate on Basis of decreasing order of  $\lambda$  or  $\nu$  is called Spectrum.



⑩ Emission spectrum of each element is unique & different or Absorption which is used as fingerprinting of elements

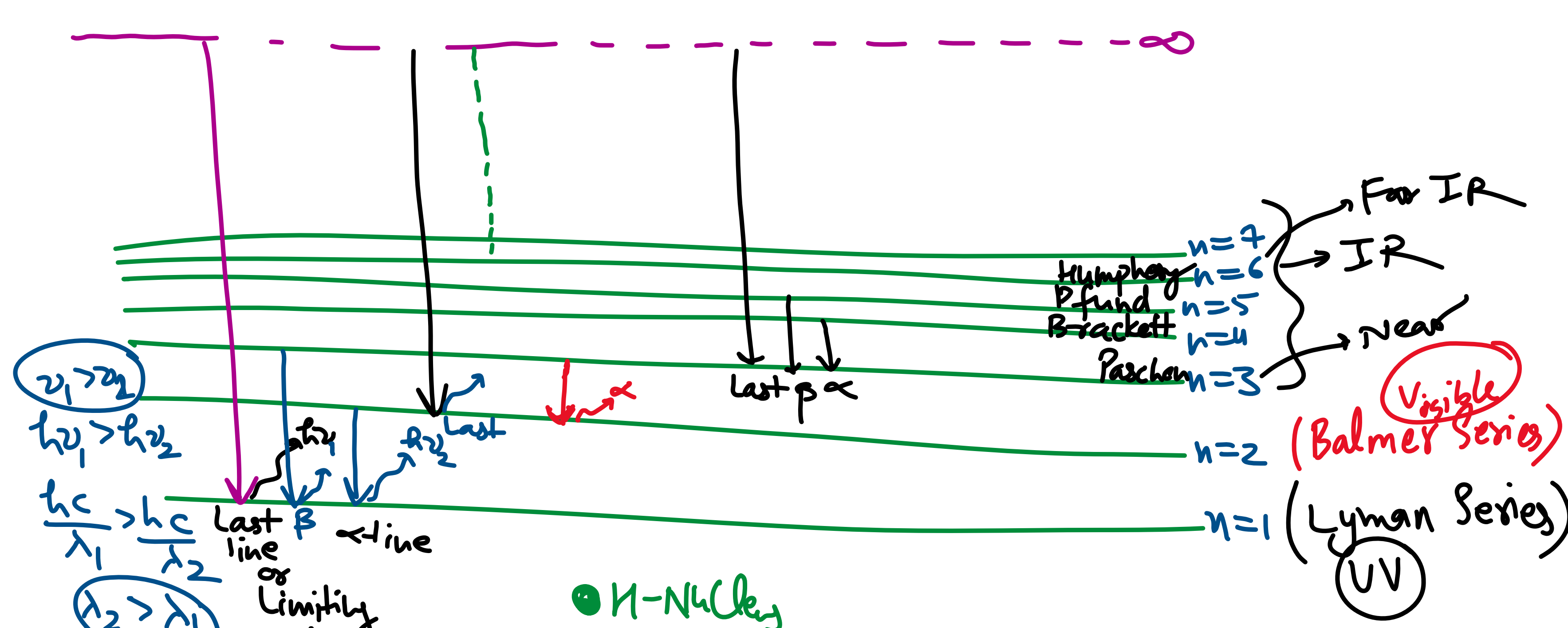
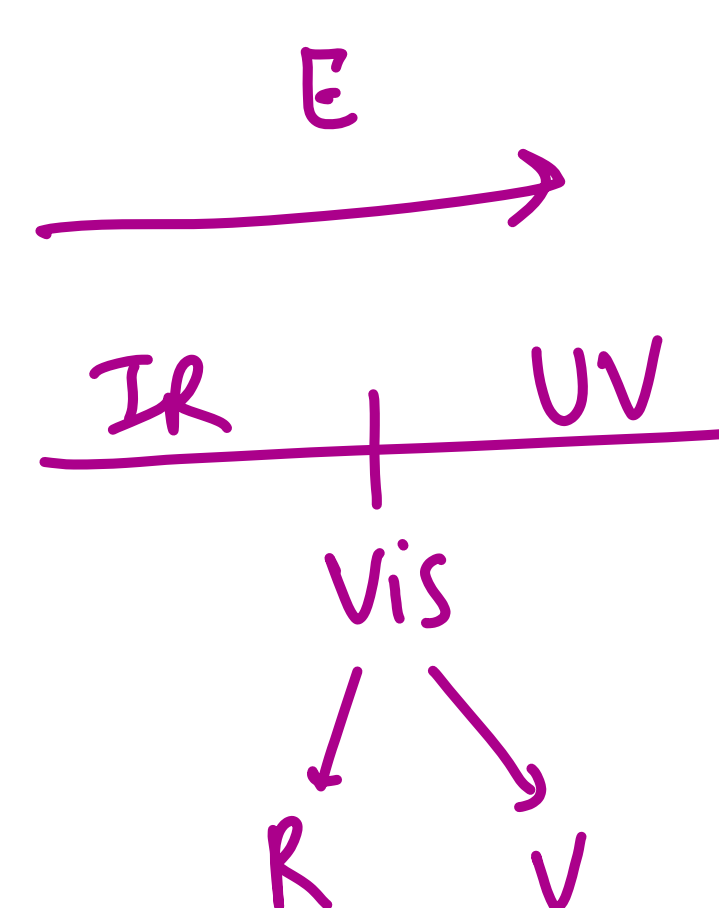
## Emission spectrum of Hydrogen (Simplest spectrum)



$\Rightarrow$  Emission spectrum of Hydrogen is observed when excited H-atoms de-excite i.e.,  $e^-$  in H-atom make transition from high level to low level.

$\Rightarrow$  Emission spectrum of H-atom was observed in 3 Regions

- UV-Region  $\rightarrow$  Studied by Lyman
- Visible Region  $\rightarrow$  " " Balmer
- IR-Region  $\rightarrow$  " " Paschen, Brackett, Pfund, Humphrey



Lyman Series ( $e^-$  lands to  $n=1$ )  
 $\alpha$ -line  $\Rightarrow 2 \rightarrow 1$   
 $\beta$ -line  $\Rightarrow 3 \rightarrow 1$   
 $\gamma$ -line  $\Rightarrow 4 \rightarrow 1$   
 $\delta$ -line  $\Rightarrow 5 \rightarrow 1$   
 $\epsilon$ -line  $\Rightarrow 6 \rightarrow 1$   
 $\zeta$ -line  $\Rightarrow 7 \rightarrow 1$   
 $\eta$ -line  $\Rightarrow 8 \rightarrow 1$   
 $\theta$ -line  $\Rightarrow 9 \rightarrow 1$   
 $\iota$ -line  $\Rightarrow 10 \rightarrow 1$   
 $\kappa$ -line  $\Rightarrow 11 \rightarrow 1$   
 $\lambda$ -line  $\Rightarrow 12 \rightarrow 1$   
 $\mu$ -line  $\Rightarrow 13 \rightarrow 1$   
 $\nu$ -line  $\Rightarrow 14 \rightarrow 1$   
 $\xi$ -line  $\Rightarrow 15 \rightarrow 1$   
 $\omicron$ -line  $\Rightarrow 16 \rightarrow 1$   
 $\pi$ -line  $\Rightarrow 17 \rightarrow 1$   
 $\rho$ -line  $\Rightarrow 18 \rightarrow 1$   
 $\sigma$ -line  $\Rightarrow 19 \rightarrow 1$   
 $\tau$ -line  $\Rightarrow 20 \rightarrow 1$   
 $\upsilon$ -line  $\Rightarrow 21 \rightarrow 1$   
 $\phi$ -line  $\Rightarrow 22 \rightarrow 1$   
 $\chi$ -line  $\Rightarrow 23 \rightarrow 1$   
 $\psi$ -line  $\Rightarrow 24 \rightarrow 1$   
 $\omega$ -line  $\Rightarrow 25 \rightarrow 1$   
 $\eta$ -line  $\Rightarrow 26 \rightarrow 1$   
 $\theta$ -line  $\Rightarrow 27 \rightarrow 1$   
 $\iota$ -line  $\Rightarrow 28 \rightarrow 1$   
 $\kappa$ -line  $\Rightarrow 29 \rightarrow 1$   
 $\lambda$ -line  $\Rightarrow 30 \rightarrow 1$   
 $\mu$ -line  $\Rightarrow 31 \rightarrow 1$   
 $\nu$ -line  $\Rightarrow 32 \rightarrow 1$   
 $\xi$ -line  $\Rightarrow 33 \rightarrow 1$   
 $\omicron$ -line  $\Rightarrow 34 \rightarrow 1$   
 $\pi$ -line  $\Rightarrow 35 \rightarrow 1$   
 $\rho$ -line  $\Rightarrow 36 \rightarrow 1$   
 $\sigma$ -line  $\Rightarrow 37 \rightarrow 1$   
 $\tau$ -line  $\Rightarrow 38 \rightarrow 1$   
 $\upsilon$ -line  $\Rightarrow 39 \rightarrow 1$   
 $\phi$ -line  $\Rightarrow 40 \rightarrow 1$   
 $\chi$ -line  $\Rightarrow 41 \rightarrow 1$   
 $\psi$ -line  $\Rightarrow 42 \rightarrow 1$   
 $\omega$ -line  $\Rightarrow 43 \rightarrow 1$   
 $\eta$ -line  $\Rightarrow 44 \rightarrow 1$   
 $\theta$ -line  $\Rightarrow 45 \rightarrow 1$   
 $\iota$ -line  $\Rightarrow 46 \rightarrow 1$   
 $\kappa$ -line  $\Rightarrow 47 \rightarrow 1$   
 $\lambda$ -line  $\Rightarrow 48 \rightarrow 1$   
 $\mu$ -line  $\Rightarrow 49 \rightarrow 1$   
 $\nu$ -line  $\Rightarrow 50 \rightarrow 1$   
 $\xi$ -line  $\Rightarrow 51 \rightarrow 1$   
 $\omicron$ -line  $\Rightarrow 52 \rightarrow 1$   
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 $\rho$ -line  $\Rightarrow 54 \rightarrow 1$   
 $\sigma$ -line  $\Rightarrow 55 \rightarrow 1$   
 $\tau$ -line  $\Rightarrow 56 \rightarrow 1$   
 $\upsilon$ -line  $\Rightarrow 57 \rightarrow 1$   
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 $\omega$ -line  $\Rightarrow 61 \rightarrow 1$   
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 $\iota$ -line  $\Rightarrow 64 \rightarrow 1$   
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 $\omicron$ -line  $\Rightarrow 70 \rightarrow 1$   
 $\pi$ -line  $\Rightarrow 71 \rightarrow 1$   
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 $\sigma$ -line  $\Rightarrow 73 \rightarrow 1$   
 $\tau$ -line  $\Rightarrow 74 \rightarrow 1$   
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 $\psi$ -line  $\Rightarrow 78 \rightarrow 1$   
 $\omega$ -line  $\Rightarrow 79 \rightarrow 1$   
 $\eta$ -line  $\Rightarrow 80 \rightarrow 1$   
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 $\xi$ -line  $\Rightarrow 87 \rightarrow 1$   
 $\omicron$ -line  $\Rightarrow 88 \rightarrow 1$   
 $\pi$ -line  $\Rightarrow 89 \rightarrow 1$   
 $\rho$ -line  $\Rightarrow 90 \rightarrow 1$   
 $\sigma$ -line  $\Rightarrow 91 \rightarrow 1$   
 $\tau$ -line  $\Rightarrow 92 \rightarrow 1$   
 $\upsilon$ -line  $\Rightarrow 93 \rightarrow 1$   
 $\phi$ -line  $\Rightarrow 94 \rightarrow 1$   
 $\chi$ -line  $\Rightarrow 95 \rightarrow 1$   
 $\psi$ -line  $\Rightarrow 96 \rightarrow 1$   
 $\omega$ -line  $\Rightarrow 97 \rightarrow 1$   
 $\eta$ -line  $\Rightarrow 98 \rightarrow 1$   
 $\theta$ -line  $\Rightarrow 99 \rightarrow 1$   
 $\iota$ -line  $\Rightarrow 100 \rightarrow 1$

Balmer Series ( $e^-$  lands to  $n=2$ )  
 $\alpha$ -line  $\Rightarrow 3 \rightarrow 2$   
 $\beta$ -line  $\Rightarrow 4 \rightarrow 2$   
 $\gamma$ -line  $\Rightarrow 5 \rightarrow 2$   
 $\delta$ -line  $\Rightarrow 6 \rightarrow 2$   
 $\epsilon$ -line  $\Rightarrow 7 \rightarrow 2$   
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 $\theta$ -line  $\Rightarrow 100 \rightarrow 2$

Paschen Series ( $e^-$  lands to  $n=3$ )  
 $4 \rightarrow 3 \Rightarrow \alpha$ -line,  $\lambda_{\max}$  for Paschen Series  
 $\infty \rightarrow 3 \Rightarrow$  last line

$$\frac{1}{\lambda} = \bar{\nu} = R Z^2 \left( \frac{1}{n_1^2} - \frac{1}{n_2^2} \right)$$

$R = \text{Rydberg const. } (n_2 > n_1)$   
 $(109677 \text{ cm}^{-1})$   
or  $1.09 \times 10^7 \text{ m}^{-1}$   
 $\downarrow$   
 $\approx 10^7 \text{ m}^{-1}$  (for numericals)